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(54) Driver circuit for solenoid

(57) A driver circuit for energizing a solenoid 11 includes first and second switches 16, 17 for determining the direction in which electric current is to flow through the solenoid 11, first and second noise removers 20, 21 for receiving signals produced by operating the switches 16, 17, first and second monostable multivibrators 18, 19 triggerable by shaped pulsed signals generated by the noise removers 20, 21, for producing signals having pulse durations required to drive the solenoid 11, and first and second relays 12, 13 energizable by the pulsed signals from the multivibrators 18, 19 for selectively passing bidirectional electric currents from a battery 24 through the solenoid 11. A resetting circuit 23 prevents unstable operation. The solenoid controls the coupling of an operating lever 4 to a vehicle bonnet lock 5.

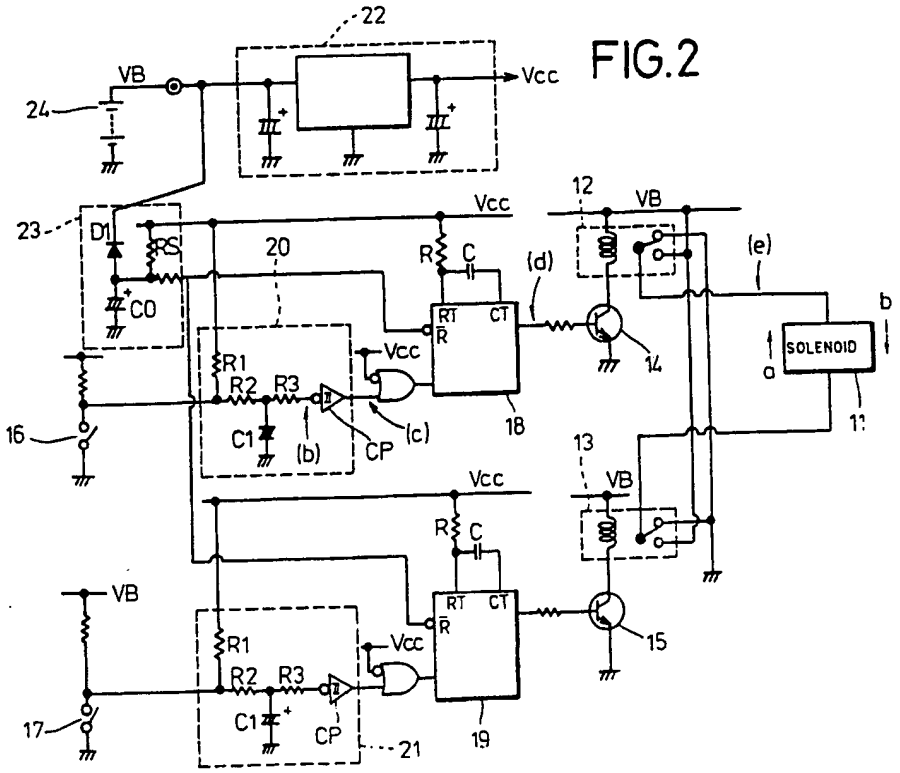

FIG.2

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FIG.1

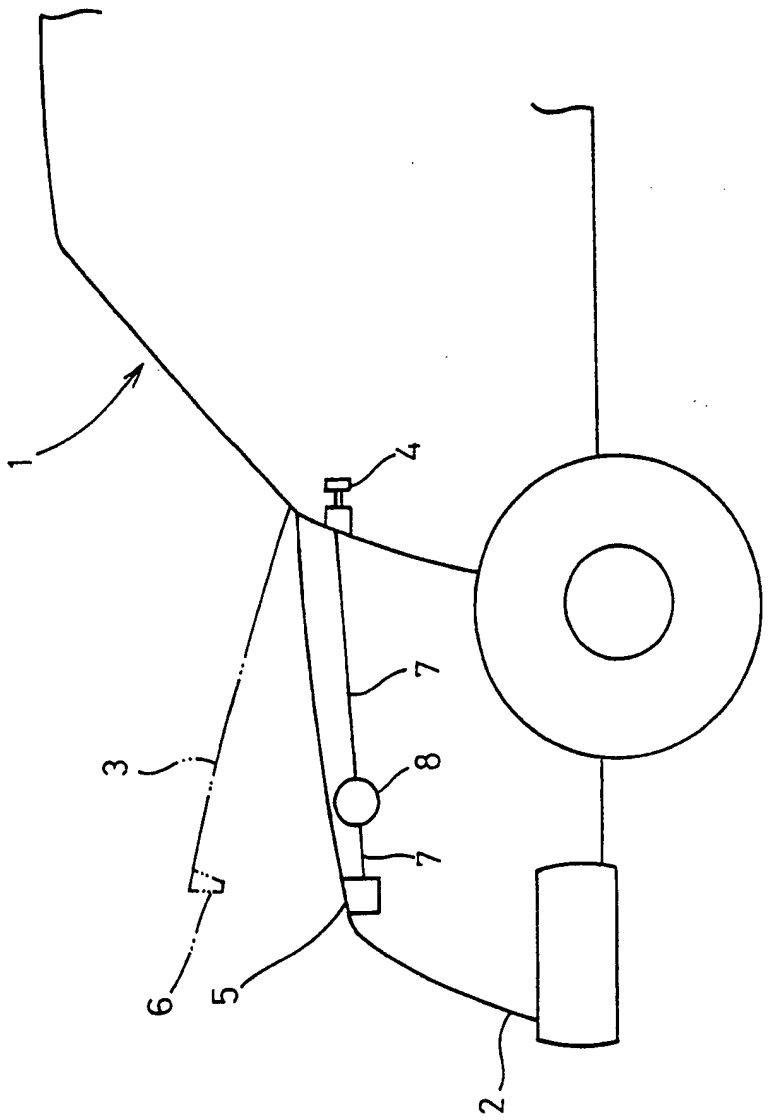

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FIG.2

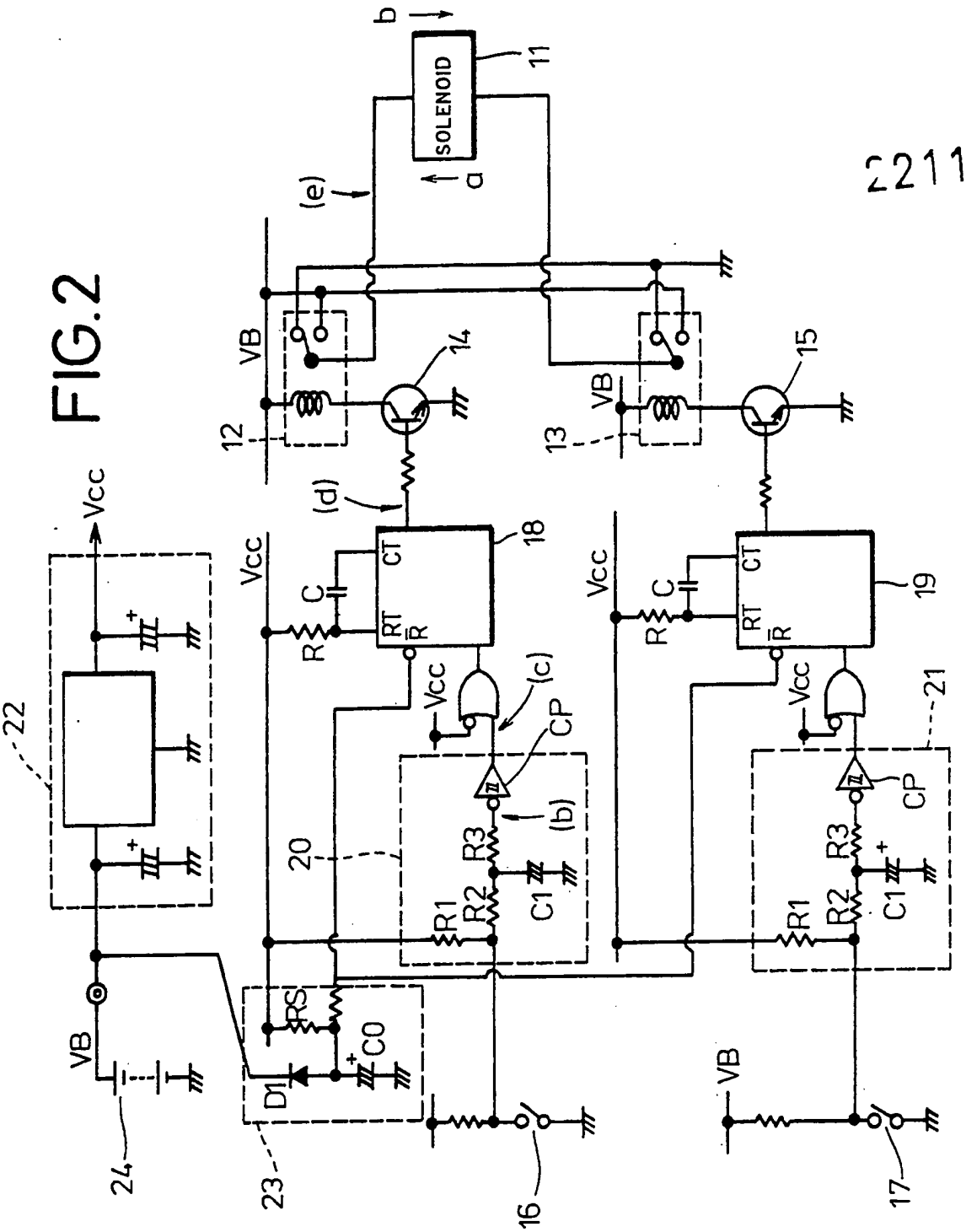

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FIG.3

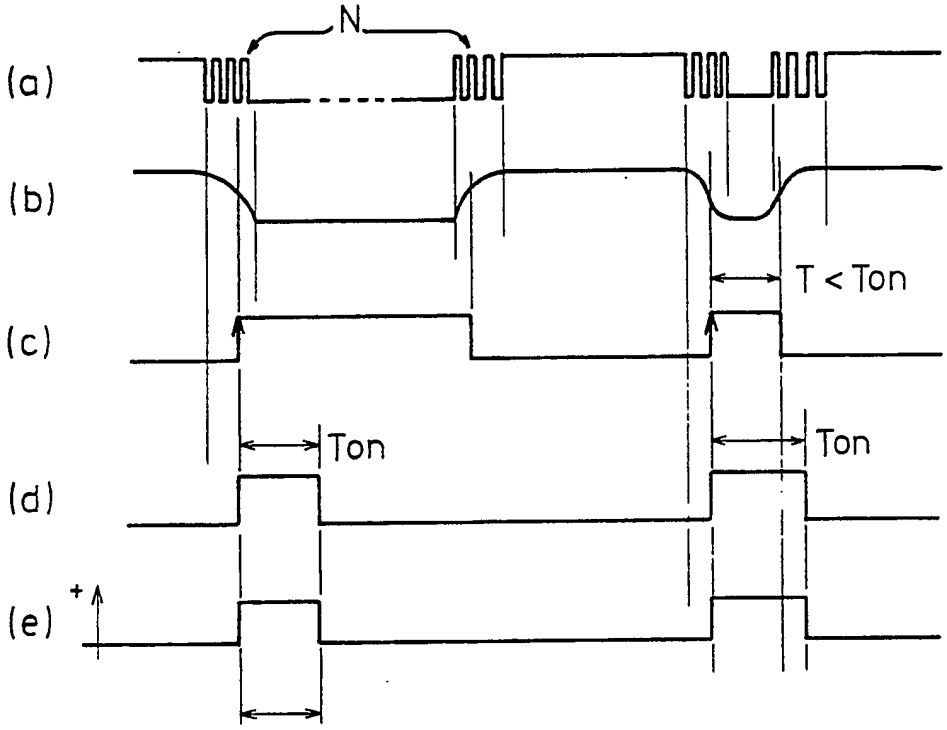
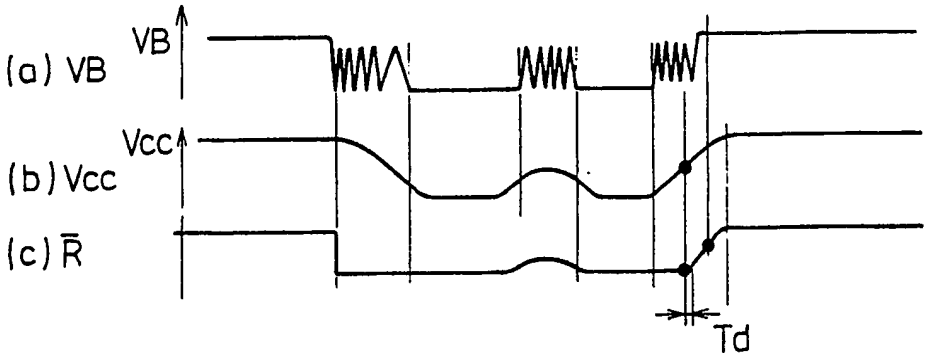


FIG.4



DRIVER CIRCUIT FOR SOLENOID

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The present invention relates to a driver circuit for a solenoid, and more particularly to a solenoid driver circuit for actuating a release mechanism disposed between an engine hood opening lever for opening the engine hood of an automobile and a hood lock device for locking the engine hood.

Automobiles have an engine compartment covered with an engine hood which can be opened by operating an engine hood opening lever disposed in the passenger compartment. A striker for coacting with the hood lock device is mounted on the free end of the engine hood. A wire cable for transmitting actuating forces from the opening lever to the hood lock device has a release mechanism.

The release mechanism is selectively actuated and inactivated by a solenoid for transmitting and cutting off actuating forces from the opening lever through the wire cable. Under normal conditions, the solenoid is energized to permit the transmission of actuating forces through the wire cable, so that the engine hood can be opened by operating the engine hood opening lever. After a predetermined process is effected, the solenoid is driven to release the wire cable so that no actuating forces will be transmitted therethrough to the hood lock device and hence the engine

hood cannot be opened even if the opening lever is operated. Therefore, parts in the engine compartment can be protected against theft.

A driver circuit for the solenoid of the release mechanism is required to energize the solenoid in a short period of time with a small amount of electric energy since the driver circuit is powered by the battery on the automobile.

It is an object of the present invention to provide a driver circuit of a simple structure which can reliably be operated with a low amount of electric energy consumption.

According to the present invention, there is provided a driver circuit for energizing a solenoid, comprising first and second switches for indicating the direction in which an electric current is to flow through the solenoid, first and second noise removers for receiving signals produced by operating the first and second switches; first and second monostable multivibrators triggerable by shaped pulsed signals generated by the first and second noise removers, for producing signals having pulse durations required to drive the solenoid; and first and second relays energizable by the pulsed signals from the first and second monostable multivibrators for selectively passing bidirectional electric currents from a battery through the solenoid.

The above and other objects, features and advantages of the present invention will become more apparent

from the following description when taken in conjunction with the accompanying drawings in which a preferred embodiment of the present invention is shown by way of illustrative example.

FIG. 1 is a schematic view of a release mechanism and associated components;

FIG. 2 is a circuit diagram of a solenoid driver circuit according to the present invention;

FIG. 3 is a diagram showing the waveforms of signals in the solenoid driver circuit; and

FIG. 4 is a diagram of the waveforms of signals in an automatic resetting circuit in the circuit shown in FIG. 2.

As shown in FIG. 1, an automobile 1 has an engine compartment 2 covered with an engine hood 3 which can be opened to the broken-line position by operating an engine hood opening lever 4 disposed in the passenger compartment. A striker 6 for coacting with the hood lock device 5 is mounted on the free end of the engine hood 3. A wire cable 7 for transmitting actuating forces from the opening lever 4 to the hood lock device 5 has a release mechanism 8.

The release mechanism 8 is selectively actuated and inactivated by a solenoid (not shown in FIG. 1) for transmitting and cutting off actuating forces from the opening

lever 4 through the wire cable 7. Under normal conditions, the solenoid is energized to permit the transmission of actuating forces through the wire cable 7, so that the engine hood 3 can be opened by operating the engine hood opening lever 4. After a predetermined process is effected, the solenoid is driven to release the wire cable 7 so that no actuating forces will be transmitted therethrough to the hood lock device 5 and hence the engine hood 3 cannot be opened even if the opening lever 4 is operated. Therefore, parts in the engine compartment 2 can be protected against theft.

FIG. 2 shows a solenoid driver circuit according to the present invention. A solenoid 11 has a coil therein through which an electric current flows in a selected direction to produce driving forces in a corresponding direction. The solenoid 11 is disposed in the release mechanism 8 shown in FIG. 1. When an electric current flows through the solenoid 11 in the direction of the arrow a, the release mechanism 8 is actuated to allow the wire cable 7 to transmit actuating forces from the opening lever 4. By passing an electric current through the solenoid 11 in the direction of the arrow b, the release mechanism 8 is inactivated to cut off the transmission of the actuating forces. First and second relays 12, 13 are connected to the opposite terminals of the solenoid 11 and have contact terminals for applying the voltage (VB) of a battery 24 on the automobile 1 to the

solenoid 11 with selected polarity between a positive terminal and a negative terminal (common line). The contacts of the first and second relays 12, 13, when they are not energized, are connected to the negative terminal of the battery 24, as shown in FIG. 2. The first and second relays 12, 13 can be energized by respective transistors 14, 15.

A switch 16 serves to inactivate the release mechanism 8, and a switch 17 serves to actuate or connect the release mechanism 8. First and second monostable multivibrators 18, 19 receive signals from the switches 16, 17 through respective first and second noise removers 20, 21. Each of the first and second noise removers 20,21 comprises resistors R1, R2, R3, a capacitor C1, and a Schmitt trigger inverter CP. The first and second noise removers 20, 21 apply signals to the first and second monostable multivibrators 18, 19 which then apply output pulse-duration signals to the transistors 14, 15. The pulse duration Ton of these pulse-duration signals is determined by the values of a resistor R and a capacitor C which are connected to RT, CT terminals. According to the circuit of the present invention, the pulse duration Ton is selected to be a time period required to energize the solenoid 11 sufficiently.

A power supply circuit 22 is connected to the battery 24 for generating a stable DC voltage Vcc to be supplied to the first and second monostable multivibrators 18, 19, the power supply circuit 22 including a zener diode, a smoothing capacitor, etc.

An automatic resetting circuit 23 comprises a diode D1 coupled to the battery 24, a resistor RS connected to the power supply circuit 22 at its DC voltage Vcc line, and a capacitor CO. The automatic resetting circuit 23 applies its output to resetting terminals $\overline{R}$ of the monostable multivibrators 18, 19. The automatic resetting circuit 23 serves to prevent the monostable multivibrators 18, 19 from operating unstably when the battery voltage is lowered or fluctuates, and may be dispensed with.

Operation of the driver circuit thus constructed is as follows:

FIG. 3 shows the waveforms of signals produced in the driver circuit. When an electric current is to pass through the solenoid 11 in the direction of the arrow b to inactivate the release mechanism 8, the switch 16 is turned on for a certain period of time. When the switch 16 is turned on, a signal which varies to a level "L" as indicated at (a) in FIG. 3 is applied to the noise remover 20. As shown, when the contacts of the switch 16 are operated, the signal contains chatter and noise N. Such chatter and noise is removed from the signal in the noise remover 20, which then produces a signal as shown at (b) in FIG. 3. The signal from the noise remover 20 is then applied to the Schmitt trigger inverter CP, which compares the applied signal with a threshold level to produce a shaped pulsed signal indi-

cated at (c) from the output terminal. The pulsed signal is impressed as a trigger signal to the monostable multivibrator 18.

The monostable multivibrator 18 is triggered by a positive-going edge of the applied trigger signal, thereby producing an output pulse-duration signal indicated at (d) in FIG. 3 which has a pulse duration Ton determined by the resistor R and the capacitor C. The pulse-duration signal turns on the transistor 14 to energize the first relay 12, connecting its contact to the positive terminal of the battery 24. At this time, the contact of the second relay 13 is connected to the negative terminal of the battery 24. Therefore, an electric current flows through the solenoid 11 in the direction of the arrow b from the first relay 12 to the second relay 13 for a period of time corresponding to the pulse duration T, so that the plunger of the solenoid 11 is moved in the corresponding direction.

For passing an electric current through the solenoid 11 in the direction of the arrow a to connect or actuate the release mechanism 8, the switch 17 is turned on for a certain period of time. The second relay 13 is energized for a predetermined period of time in the same process as described above to connect the contact thereof to the positive terminal of the battery 24, whereupon an electric current flows through the solenoid 11 in the direction of the arrow a to move the plunger in the opposite direction.

Thus, by selectively turning on the switches 16, 17, an electric current can be passed through the solenoid 11 for a time required to energize the same, thus reliably driving the solenoid 11.

FIG. 4 shows the waveforms of signals in the automatic resetting circuit 23. When the voltage VB of the battery 24 fluctuates and then drops as indicated at (a), the DC voltage Vcc produced by the power supply circuit 22 is gradually lowered as indicated at (b). The capacitor CO in the automatic resetting circuit 23 is rapidly discharged via the diode D1 to apply a resetting signal as indicated at (c) to the resetting terminal $\overline{R}$ of each of the monostable multivibrators 18, 19. Therefore, before the supplied DC voltage Vcc drops, the monostable multivibrators 18, 19 are reset to prevent the solenoid 11 from being driven accidentally. Upon an abrupt change in the battery voltage VB, the monostable multivibrators 18, 19 are released from the reset condition with a certain time delay Td, thus also preventing the solenoid 11 from being driven accidentally.

With the present invention, as described above, when driving the solenoid, a driving current is passed therethrough in a selected direction for a predetermined time period Ton. The driver circuit is of a simple arrangement which is capable of reliably energizing the solenoid with low electric power consumption.

Although a certain preferred embodiment has been shown and described, it should be understood that many changes and modifications may be made therein without departing from the scope of the appended claims.

CLAIMS:

1. A driver circuit for energizing a solenoid, comprising:

first and second switches for indicating the direction in which an electric current is to flow through the solenoid;

first and second noise removers for receiving signals produced by operating said first and second switches;

first and second monostable multivibrators triggerable by shaped pulsed signals generated by said first and second noise removers, for producing signals having pulse durations required to drive said solenoid; and

first and second relays energizable by the pulsed signals from said first and second monostable multivibrators for selectively passing bidirectional electric currents from a battery through said solenoid.

2. A driver circuit according to claim 1, further including an automatic resetting circuit for detecting a change in an output voltage from said battery to apply a resetting signal to said first and second monostable multivibrators.

3. A driver circuit as claimed in claim 1 or claim 2 substantially as hereinbefore described and shown in the accompanying drawings.